



## EFFECT OF THE SUBSTRATE COMPOSITION ON YIELD AND QUALITY OF BASIL (*OCIMUM BASILICUM L.*)

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### ABSTRACT

Basil (*Ocimum basilicum L.*) is an aromatic herb which has a high value and is of high demand in the world. Basil in Ukraine is grown mainly in small farms and country house gardens. The influence of the substrate composition (proportions of peat to perlite) on the yield of herbs and on the accumulation of biologically active substances with antioxidant properties was studied for two cultivars grown in a greenhouse. It was found that the substrate composition influenced the fresh and dry weight, as well as level of total phenolic compounds, carotenoids and essential oils of basil. The herbs yield, ascorbic acid and essential oils concentration increased at an addition of 20, 40 and 60% of perlite, and decreased at 80% as compared to 100% peat. Plants of both cultivars accumulated the highest amount of phenolic substances when grown in the substrate, which contained 40% of peat and 60% of perlite. The concentration of ascorbic acid increased in plants grown in the substrates with 20, 40 and 60% of perlite, mostly at 40%. Significant increase in the concentration of carotenoids differed for cultivars and in 'Bad'oryi' cv. increased at 20 and 40% perlite, but in 'Filosof' at 20, 40 and 60%.

**Key words:** basil, yield, total phenolic compounds, ascorbic acid, carotenoids, essential oil, substrate

### INTRODUCTION

Aromatic herbs have high antioxidant activity, which is caused by the presence of high content of different classes of biologically active substances (Dapkevicius et al. 1998; Suhaj 2006) that play an important role in the prevention of many diseases due to the detoxification of reactive oxygen species.

Basil (*Ocimum basilicum*), which belongs to the Lamiaceae family, is one of the most popular herbs being grown extensively in many climatic zones, and it's consumer demand is increasing. Fresh or dried flowers and leaves of basil are used as food ingredients, in medicine and cosmetology (Nurzyńska-Wierdak 2012) and in landscape design as an ornamental scent plant (Makri & Kintzios 2008). It was shown that basil plants accumulate quite a lot of biologically active sub-

stances with antioxidant properties (Kwee & Niemeyer 2011; Surveswaran et al. 2007), including ascorbic acid, carotenoids, polyphenolics, and essential oils (0.1–0.2%) (Zheng & Wang 2001; Shan et al. 2005).

Experimental studies have revealed that such factors as genotype, light intensity and quality (Shiga et al. 2009; Shoji et al. 2009), moisture content (Heidari & Golpayegani 2012), mineral nutrition (Nguyen & Niemeyer 2008), salinity (Tarchoune et al. 2012) have a significant effect on yield and accumulation of biologically active substances in basil. However, no data showing the effect of different substrates under greenhouse conditions on the accumulation of antioxidants is available. This fact substantiates the relevance of study on the impact of composition of substrates on the herb's yield and the content of active ingredients in basil cultivated in a greenhouse.

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## MATERIALS AND METHODS

Two basil cultivars of Ukrainian selection, 'Bad'oryi' with green leaves and 'Filosof' with purple leaves, were used in the experiment.

Peat and perlite mixtures (fractions 2–5 mm) in different proportions were used: 1 – peat 100% (the control); 2 – peat 80%, perlite – 20%; 3 – peat 60%, perlite 40%; 4 – peat 40%, perlite 60%; 5 – peat 20%, perlite 80%.

The degree of peat decomposition was 10%, ash content was 6%, peat density was  $0.15 \text{ g}\cdot\text{cm}^{-3}$ , porosity was 86% and the content of particles of 6–16 mm size was up to 80%. Substrates humidity was at 70–75%. Fertilizer contained N – 110, P – 30, K – 170, Mg –  $45 \text{ g}\cdot\text{dm}^{-3}$  was added into the prepared substrates. Additionally, the solution of fertilizers was applied with drip irrigation after each cutting of the green mass of basil: N – 40, P – 10, K – 60, Mg – 15, Ca –  $140 \text{ g}\cdot\text{dm}^{-3}$ . The pH was neutral and ranged from 6.2 in the peat to 7.0 in the substrate with highest rate of perlite.

The experiment was conducted under the greenhouse conditions in years 2014–2015. Seeds were sown in the 2nd decade of March. At the phase of 1–2 leaves, the plants were transplanted into pots of  $6 \times 6 \text{ cm}$ . At the phase of 3–4 leaves, the seedlings were transplanted to the above substrates, to the same size of pots with the planting scheme  $30 \times 20 \text{ cm}$  (16 plants per  $\text{m}^2$ ). Air temperature in the greenhouse was maintained at  $27 \text{ }^\circ\text{C}/22 \text{ }^\circ\text{C}$  (day/night). Relative humidity in the greenhouse ranged between 92.0–96.0%.

In each experimental treatment, there were 5 plants, and it was repeated 5 times. Green mass was harvested at every 14 d approximately, by cutting the shoot tips 15–20 cm in length and it was weighed immediately after harvest. The samples (500 g in 5 times repeated) for determining the content of total polyphenolic compounds, ascorbic acid, carotenoids and essential oils were selected from 25 test plants at the inflorescence growth phase.

All data were analyzed statistically using Agrostat New software (developed by the local Agricultural University) and Microsoft Excel. We used the three-factorial analysis of variance for the calculations. Significant differences between individual means were determined using Fisher's protected

least significant difference (LSD) test, with the level of significance set at 5%.

### Determination of total phenolic content

The content of polyphenolic compounds was determined by Folin-Denis reagent (DSTU 4373:2005 2006). The method comprised complexation reaction of polyphenols with Folin-Denis reagent and the formation of colored substances, followed by determination of the optical density of solution.

The samples (4.0 g) were quantitatively transferred to a conical flask of  $50 \text{ cm}^3$ , pre-warmed to  $60 \text{ }^\circ\text{C}$  75% ethanol was added. For inactivation of enzymes, the flask was kept for 15 minutes in a water bath at  $80 \text{ }^\circ\text{C}$ . After cooling, the extract was quantitatively transferred to a volumetric flask and adjusted to  $50 \text{ cm}^3$  by 75% ethanol. The obtained extract was thoroughly stirred and filtered.

Preparation of the eluate ( $D_1$ ):  $1 \text{ cm}^3$  of the extract was transferred to a test tube containing  $7.5 \text{ cm}^3$  of distilled water to which  $0.5 \text{ cm}^3$  of the Folin-Denis reagent was added. After 3 minutes,  $1 \text{ cm}^3$  of saturated sodium carbonate solution was added.

Preparation of the control of eluate ( $D_k$ ): for monitoring of the colored substances in the second tube,  $1 \text{ cm}^3$  of the extract,  $8.0 \text{ cm}^3$  of the distilled water and  $1 \text{ cm}^3$  of saturated sodium carbonate solution were transferred without adding Folin-Dennis reagent. Preparation of control solution (K):  $8.5 \text{ cm}^3$  of distilled water was poured into the test tube. Then  $0.5 \text{ cm}^3$  of Folin-Denis reagent and  $1 \text{ cm}^3$  of sodium carbonate solution were added into the tube. After 60 minutes, the eluate ( $D_1$ ) was measured spectrophotometrically in the presence of the control solution (K); control of eluate ( $D_k$ ) was measured in the presence of distilled water. The measurements were carried out at a wavelength of 670 nm. The optical density of the sample was determined according to the formula:  $D = D_1 - D_k$ . The amount of phenols was determined by the calibration curve constructed with quercetin.

### Determination of vitamin C

In order to determine the vitamin C content, the iodometric method was used (Naichenko 2001). The essence of the method is in the measurement of reducing power of ascorbic acid. In this method, ascorbic acid is oxidized and restores the potassium

iodide to free iodine. The amount of free iodine is defined by the color reaction with a starch.

The samples (2.0–10.0 g) were weighed and triturated with a small amount of water in a porcelain mortar. Then the substance was quantitatively transferred to a volumetric flask of 100 cm<sup>3</sup>, adjusted to the mark and filtered. For titration, 10 cm<sup>3</sup> of extract was taken and 1 cm<sup>3</sup> of 2% HCl, 0.5 cm<sup>3</sup> of 1% potassium iodine solution, 2 cm<sup>3</sup> of 0.5% starch solution and 6–7 cm<sup>3</sup> of distilled water were added. Titration with 0.01 N solution of potassium iodide was conducted until a persistent blue color appeared. At the same time, the control titration using 10 cm<sup>3</sup> of water instead of an extract was also conducted. Quantification of vitamin C content was done according to the relation: 1 cm<sup>3</sup> 0.01 N potassium iodide is equivalent to 0.8806 mg of vitamin C. All determinations were performed in triplicate, with calculating their mean arithmetic value.

#### Determination of carotenoids

The content of carotenoids was determined spectrophotometrically by extracting the pigments with 100% acetone with subsequent determination of optical density of pigments at the wavelength of 440.5 nm (Musiyenko et al. 2001).

For the experiment, samples of 150–200 mg were taken and carefully rubbed with MgCO<sub>3</sub> and 5 cm<sup>3</sup> of acetone. The extract was poured through a glass filter in a volumetric flask of 25 cm<sup>3</sup>. A Bunsen flask was rinsed several times with small portions of acetone and adjusted to the mark with pure acetone. The obtained acetone extract contains the sum of green and yellow pigments. Then the measurements of optical density (D) at wavelengths of 662, 644, and 440.5 nm were carried out.

The concentration of pigment was calculated by the equations:

$$X_{(\text{Chl a})} = 9.784D_{662} - 0.990D_{644};$$

$$X_{(\text{Chl b})} = 21.426D_{644} - 4.650D_{662};$$

$$X_{(\text{Chl a} + \text{Chl b})} = 5.134D_{662} + 20.436D_{644};$$

$$X_{(\text{Carotenoids})} = 4.695D_{440.5} - 0.268X_{(\text{Chl a} + \text{Chl b})}.$$

The content of pigments (A) in the plant material was calculated by the formula:

$$A = X \cdot v / H \cdot 100;$$

X – the pigments concentration, mg · dm<sup>-3</sup>;

v – the volume of extract, ml (25 cm<sup>3</sup>);

H – the sample of plant material, g (0.1–0.2 g).

#### Determination of essential oils

The amount of essential oils in basil leaves was determined by hydro distillation from the raw material of plants with steam, and a subsequent measurement of their volume expressed as a percentage relative to the dry raw material. Ginsberg installation was used for this study.

## RESULTS AND DISCUSSION

Basil plants grown in the greenhouse in peat-mineral substrates produced up to 5 cuttings per plant. An exception was 'Bad'oryi' when grown in substrates with the 60 and 80% of perlite, where only 3 cuttings were produced.

On an average for 2 years, the yield of fresh mass was 7.14 and 7.86 kg per m<sup>2</sup>, for 'Filosof' and 'Bad'oryi', respectively (Table 1). An addition of 20, 40 or 60% perlite to peat caused increase of fresh and dry mass (the highest at 40%).

The addition of 40% perlite increased the fresh mass by 34 and 33%, and dry mass by 58 and 34%, for 'Filosof' and 'Bad'oryi', respectively. Further saturation of substrate with perlite to 80% lowered green mass of both cultivars of basil by 59% in 'Bad'oryi' and by 40% in 'Filosof' and dry mass by 66 and 60%, respectively, as compared to pure peat.

The analysis of three-factorial experiment showed that the decisive factors in shaping the yield of both cultivars of basil were the substrate factor (share of factor influence – 91.1%), year of cultivation (share of factor influence – 3.1%) and cultivar (share of factor influence – 2.8%).

The above results showed the dependence of fresh and dry mass from the proportion of perlite that can be explained by their impact on physical and water properties of a growth substrate. It is well known that the growth and development of plants largely depend on specific and volumetric weight, total porosity and moisture capacity of the substrate. Peat is characterized by high porosity and low specific and volumetric weight. However, due to high water capacity, it is virtually impossible to adjust the irrigation regime. Peat becomes compacted with time, decreasing its porosity, and demonstrating the over accumulation of moisture. This leads to deterioration of the root environment.

In turn, the supplementation with perlite contributes to the maintenance of water and air/oxygen balance of the root environment.

A necessary component of the yield of herbs is the concentration of biologically active compounds, especially those of antioxidant activity. Studies have shown that the accumulation of the biologically active substances differed with cultivar, year of cultivation and substrate.

The content of polyphenolic compounds was significantly higher in 'Filosof'. On average from two years of study, 'Filosof' with purple leaves

accumulated 17.2% polyphenolic substances more than 'Bad'oryi' with green leaves (Table 2).

In 2014, the concentration of total phenolic compounds was more than two times lower than that in 2015. Similarly, as with fresh and dry mass, the concentration of total phenolic grew with an increased rate of perlite up to 60% when it was by 32–36% higher ('Bad'oryi') and 23–24% higher in 'Filosof' in comparison to the control (100% peat). The lowest concentration of phenolics was found in plants grown in the substrate supplemented with 80% of perlite.

Table 1. Fresh (FW) and dry weight (DW) of basil, mean  $\pm$  SD kg per m<sup>2</sup>, n = 5)

Cultivar	Substrate composition	Year				Mean for year			
		2014		2015		fresh weight	% to peat	dry weight	% to peat
		fresh weight	dry weight	fresh weight	dry weight				
'Bad'oryi'	100% peat	7.44 $\pm$ 0.09	0.84 $\pm$ 0.010	6.78 $\pm$ 0.04	0.74 $\pm$ 0.005	7.11 $\pm$ 0.06		0.79 $\pm$ 0.007	
	80% peat + 20% perlite	9.19 $\pm$ 0.10	1.13 $\pm$ 0.012	8.19 $\pm$ 0.07	0.99 $\pm$ 0.008	8.69 $\pm$ 0.07	+22%	1.06 $\pm$ 0.009	+34%
	60% peat + 40% perlite	9.95 $\pm$ 0.07	1.31 $\pm$ 0.008	9.14 $\pm$ 0.03	1.18 $\pm$ 0.004	9.55 $\pm$ 0.03	+34%	1.25 $\pm$ 0.00	+58%
	40% peat + 60% perlite	7.68 $\pm$ 0.07	0.93 $\pm$ 0.010	7.08 $\pm$ 0.04	0.88 $\pm$ 0.004	7.38 $\pm$ 0.04	+4%	0.91 $\pm$ 0.005	+15%
	20% peat + 80% perlite	3.17 $\pm$ 0.12	0.29 $\pm$ 0.010	2.74 $\pm$ 0.04	0.25 $\pm$ 0.004	2.95 $\pm$ 0.07	-59%	0.27 $\pm$ 0.006	-66%
Mean for cultivar		7.49	0.90	6.79	0.81	7.14		0.86	
'Filosof'	100% peat	7.92 $\pm$ 0.04	0.89 $\pm$ 0.004	6.83 $\pm$ 0.10	0.75 $\pm$ 0.011	7.38 $\pm$ 0.06		0.82 $\pm$ 0.006	
	80% peat + 20% perlite	9.37 $\pm$ 0.07	1.06 $\pm$ 0.008	8.25 $\pm$ 0.05	0.92 $\pm$ 0.006	8.81 $\pm$ 0.04	+19%	0.99 $\pm$ 0.004	+21%
	60% peat + 40% perlite	10.32 $\pm$ 0.07	1.18 $\pm$ 0.007	9.24 $\pm$ 0.05	1.02 $\pm$ 0.005	9.78 $\pm$ 0.04	+33%	1.10 $\pm$ 0.004	+34%
	40% peat + 60% perlite	9.26 $\pm$ 0.06	1.04 $\pm$ 0.007	8.55 $\pm$ 0.02	0.95 $\pm$ 0.002	8.91 $\pm$ 0.03	+21%	1.00 $\pm$ 0.004	+22%
	20% peat + 80% perlite	4.44 $\pm$ 0.04	0.40 $\pm$ 0.003	4.38 $\pm$ 0.11	0.27 $\pm$ 0.007	4.41 $\pm$ 0.06	-40%	0.33 $\pm$ 0.004	-60%
Mean for cultivar		8.26	0.92	7.45	0.78	7.86		0.85	
Mean for substrate	100% peat	7.68	0.87	6.81	0.75	7.25		0.81	
	80% peat + 20% perlite	9.28	1.1	8.22	0.96	8.75		1.03	
	60% peat + 40% perlite	10.14	1.25	9.19	1.10	9.67		1.18	
	40% peat + 60% perlite	8.47	1.00	7.57	0.92	8.15		0.96	
	20% peat + 80% perlite	3.81	0.35	3.56	0.26	3.68		0.30	
Mean		7.88	0.91	7.12	0.80	7.20		0.86	

LSD<sub>0.05</sub> FW/DW: year – 0.1/0.001; cultivar – 0.2/0.002; substrate – 0.2/0.002

Table 2. Total phenolic compounds (TPC) of basil,  $\text{mg} \times 100 \cdot \text{g}^{-1}$  of fresh mass were added into the prepared substrates; mean  $\pm$  SD, (n = 5)

Cultivar	Substrate composition	Year				Mean for year	
		2014		2015		TPC $\pm$ SD	% to peat
		TPC $\pm$ SD	% to peat	TPC $\pm$ SD	% to peat		
'Bad'oryi'	100% peat	166.7 $\pm$ 0.66		434.3 $\pm$ 1.69		300.5 $\pm$ 0.97	
	80% peat + 20% perlite	178.0 $\pm$ 1.26	+ 7%	520.6 $\pm$ 2.71	+20%	349.3 $\pm$ 1.83	+16%
	60% peat + 40% perlite	200.2 $\pm$ 1.14	+ 20%	571.0 $\pm$ 3.13	+31%	385.6 $\pm$ 1.44	+28%
	40% peat + 60% perlite	219.5 $\pm$ 1.26	+32%	591.8 $\pm$ 11.55	+36%	405.6 $\pm$ 6.21	+35%
	20% peat + 80% perlite	143.9 $\pm$ 2.27	-14%	409.5 $\pm$ 3.66	-6%	276.7 $\pm$ 2.02	-8%
	Mean for cultivar	181.8	+9%	505.6	+16%	343.8	+14%
'Filosof'	100% peat	216.6 $\pm$ 1.12		509.8 $\pm$ 7.98		363.2 $\pm$ 4.07	
	80% peat + 20% perlite	233.1 $\pm$ 1.52	+8%	570.6 $\pm$ 1.57	+12%	401.9 $\pm$ 0.49	+11%
	60% peat + 40% perlite	256.5 $\pm$ 0.85	+18%	604.0 $\pm$ 2.55	+19%	430.3 $\pm$ 1.61	+18%
	40% peat + 60% perlite	266.0 $\pm$ 1.07	+23%	633.5 $\pm$ 2.42	+24%	449.8 $\pm$ 1.02	+24%
	20% peat + 80% perlite	204.8 $\pm$ 3.79	-9%	530.0 $\pm$ 9.81	+4%	367.4 $\pm$ 3.13	+1%
	Mean for cultivar	235.6		569.8		402.4	
Mean for substrate	100% peat	191.7		472.1		324.7	
	80% peat + 20% perlite	205.6		545.6		375.6	
	60% peat + 40% perlite	228.4		587.5		408.0	
	40% peat + 60% perlite	242.8		612.7		427.7	
	20% peat + 80% perlite	174.4		469.8		322.1	
	Mean for year	208.7		537.7		373.1	

LSD<sub>0.05</sub> total phenolic compound: year -18.0; cultivar - 8.4; substrate - 12.5

Studies of other authors show that basil with purple leaves accumulate more phenols in comparison with green-leaf cultivars. For example, Juliani and Simon (2002) reported that purple leaves basil cultivars contained from 126.2 to 81.7 mg phenolic per 1 g dry weight while the green leaves cultivars from 35.6 to 62.9 mg per g of dry weight. This fact can be explained by the presence of anthocyanins in pigment complex of purple basil.

The accumulation of phenolic substances was dependent on the year of study (the share of factor

influence - 89.8%), cultivars (the share of factor influence - 2.9%) and substrates (the share of factor influence - 5.6%).

The production and accumulation of phenolic compounds is a process largely dependent on many environmental factors. Given the fact that the temperature in the greenhouse was maintained at the same level (25-27 °C), the main uncontrolled factor, which could greatly affect the yield and accumulation of biologically active substances was the intensity of sunlight. The flow of basic metabolic

processes such as photosynthesis, respiration, transpiration, root and foliar nutrition of plants depends on the sunlight (Chang et al. 2008).

Light level at the stage of formation of 1 pair of leaves – budding period was diverse through years. Thus, the total cloudiness of the third 10 days of March – first 10 days of April 2015 was 6–7 points, and the lowest level of the cloudiness was 5 points; while in 2014 these rates were at 3 and 1, respectively. The second and third 10 days of April almost did not differ for years; total cloudiness was 4–5 points, and the lowest level of the cloudiness was 2 points. The first 10 days of May 2015 was characterized by higher cloudiness. During this period, the total cloudiness was 7 points, and the lowest

level was 5 points, while in 2014, these indices were at 4 and 1 points respectively. There are many publications that show differences in polyphenols content depending on the harvest season, year, light levels, etc. (Proestos et al. 2005; Atoui et al. 2005; Škerget et al. 2005; Katalinic et al. 2006).

The content of ascorbic acid in both cultivars ranged from 14.0 to 26.9 mg per 100 g of fresh weight. Similar results were obtained in studies by other authors (Holland et al. 1991; Dumbravă et al. 2012). In our study, on an average, the cultivar with purple leaves accumulates 18.4% more ascorbic acid than green-leaves cultivar. The tendency in vitamin C accumulation was also dependent on the substrate composition but the highest was at 40% of perlite (Table 3).

Table 3. Ascorbic acid (AA) in basil, mg × 100 g<sup>-1</sup> of fresh mass, mean ± SD, (n = 5)

Cultivar	Substrate composition	Year				Average for year	
		2014		2015		AA ± SD	% to peat
		AA ± SD	% to peat	AA ± SD	% to peat		
'Bad'oryi'	100% peat	14.00 ± 0.45		16.84 ± 0.35		15.41 ± 0.29	
	80% peat + 20% perlite	16.60 ± 0.63	+19%	18.60 ± 0.55	+10%	17.61 ± 0.56	+14%
	60% peat + 40% perlite	20.50 ± 1.48	+46%	23.56 ± 0.45	+40%	22.02 ± 0.52	+43%
	40% peat + 60% perlite	17.10 ± 0.79	+22%	21.02 ± 1.21	+25%	19.10 ± 0.75	+24%
	20% peat + 80% perlite	14.44 ± 1.28	+3%	18.60 ± 0.79	+10%	15.03 ± 0.45	-2%
	Mean for cultivar	16.5	+18%	19.72	+17%	17.83	+16%
'Filosof'	100% peat	18.16 ± 1.07		19.50 ± 0.30		18.82 ± 0.39	
	80% peat + 20% perlite	21.57 ± 0.20	+19%	22.57 ± 0.66	+15.7%	22.07 ± 0.31	+17%
	60% peat + 40% perlite	25.76 ± 0.82	+42%	26.86 ± 0.28	+38%	26.31 ± 0.36	+40%
	40% peat + 60% perlite	22.20 ± 0.41	+22%	19.70 ± 0.58	+1%	21.00 ± 0.33	+12%
	20% peat + 80% perlite	15.74 ± 0.36	-13%	18.8 ± 0.38	-4%	17.28 ± 0.20	-8%
	Mean for cultivar	20.69		21.49		21.10	
Mean for substrate	100% peat	16.08		18.17		17.12	
	80% peat + 20% perlite	19.01		20.59		21.96	
	60% peat + 40% perlite	23.13		25.21		24.17	
	40% peat + 60% perlite	19.65		20.36		20.10	
	20% peat + 80% perlite	15.05		18.7		16.16	
	Mean for year	18.6		20.61		19.47	

LSD<sub>0.05</sub> ascorbic acid: year -1.3; cultivar - 1.6; substrate - 1.1

In this experimental variant, the vitamin C content increased by 43.4% in 'Bad'oryi' and by 39.1% in 'Filosof' in comparison with the control variant. The further saturation of the substrate with perlite was ineffective. It was established that the substrates have a determining influence on the accumulation of vitamin C in basil. Also, more ascorbic acid was noted in 2015; it concerned mostly green-leaf cultivar. The share of substrate factor influence was 55.7%, the share of cultivar factor was 18.9% and the share of year factor was 9.3%.

Supplementation of the substrates with perlite had much weaker influence on the accumulation of carotenoids in basil plants (Table 4). Carotenoids are a class of secondary plant compounds with multiple functions such as: structure stabilization, light harvesting and energy dissipation (Kopsell et al. 2005). Also, they have an important role in the protection of plants from photooxidative (Mortensen et al. 2001). The studies of other authors showed that the level of carotenoids of basil can vary between  $0.38 \text{ mg} \cdot \text{g}^{-1}$  (Hawrylak-Nowak 2008) to  $59 \text{ mg} \cdot \text{g}^{-1}$  (Matea et al. 2010).

Table 4. Carotenoids (C) in basil,  $\text{mg} \times 100 \text{ g}^{-1}$  of fresh mass, mean  $\pm$  SD, (n = 5)

Cultivar	Substrate composition	Year				Mean for year	
		2014		2015		C $\pm$ SD	% to peat
		C $\pm$ SD	% to peat	C $\pm$ SD	% to peat		
'Bad'oryi'	100% peat	37.0 $\pm$ 0.45		39.0 $\pm$ 1.14		38.0 $\pm$ 0.58	
	80% peat + 20% perlite	42.4 $\pm$ 0.81	+15%	39.8 $\pm$ 1.24	+2%	41.1 $\pm$ 0.51	+8%
	60% peat + 40% perlite	46.2 $\pm$ 1.02	+25%	41.0 $\pm$ 0.71	+5%	43.6 $\pm$ 0.37	+15%
	40% peat + 60% perlite	32.6 $\pm$ 1.29	-12%	35.0 $\pm$ 0.32	-10%	34.0 $\pm$ 0.58	-11%
	20% peat + 80% perlite	25.4 $\pm$ 1.08	-31%	26.0 $\pm$ 0.71	-33%	25.7 $\pm$ 0.74	-32%
	Mean for cultivar	36.7	-1%	36.2	-7%	36.5	-4%
'Filosof'	100% peat	42.2 $\pm$ 1.28		40.4 $\pm$ 1.78		41.3 $\pm$ 0.97	
	80% peat + 20% perlite	45.4 $\pm$ 0.40	+8%	45.0 $\pm$ 0.32	+11%	45.2 $\pm$ 0.25	+9%
	60% peat + 40% perlite	49.6 $\pm$ 0.25	+18%	46.6 $\pm$ 0.75	+15%	48.1 $\pm$ 0.40	+16%
	40% peat + 60% perlite	50.0 $\pm$ 0.89	+18%	47.2 $\pm$ 0.37	+17%	48.6 $\pm$ 0.58	+18%
	20% peat + 80% perlite	32.8 $\pm$ 1.36	-22.2	34.8 $\pm$ 1.24	-14%	33.8 $\pm$ 0.89	-18%
	Mean for cultivar	44.0		42.8		43.4	
Mean for substrate	100% peat	39.6		39.7		39.7	
	80% peat + 20% perlite	43.5		42.4		43.2	
	60% peat + 40% perlite	47.5		43.8		45.9	
	40% peat + 60% perlite	41.3		41.1		41.3	
	20% peat + 80% perlite	29.1		30.4		29.8	
	Mean for year	40.4		39.5		40.0	

LSD<sub>0.05</sub> carotenoids: year -4.4; cultivar - 4.9; substrate - 2.4.

Table 4 shows that the highest increase in carotenoid level of both cultivars occurred at 40% of perlite and was higher by 15% for 'Bad'oryi' and by 17% in 'Filosof' in comparison with the control. On the substrate which contained only 20% of peat and 80% of perlite carotenoid levels decreased by 1.5 times in 'Bad'oryi' and by 1.2 times in 'Filosof' Significant impact on the accumulation of carotenoids in the pigment complex of basil was provided both by substrate (substrate factor share – 57.7%) and cultivar (cultivar factor share – 23.2%). The action of year of culture was insignificant (the share of factor – 0.4%).

The concentration of essential oils in the leaves of both cultivars ranged between 0.09% – 0.19% and on average was 21% more in basil with green leaves (Table 5).

In 'Bad'oryi', the same concentration of essential oils was at 20, 40 and 60% of perlite in both years of culture and in 'Filosof' at 40 and 60% of perlite in 2014 and 2015; but in the second year, the increment was higher and reached 86% in comparison with control (100% peat). When 80% of perlite was added to the substrate, the content of essential oils had reduced by 24 and 46% compared to the control.

Table 5. Essential oils (EO) in basil,% of fresh mass, mean  $\pm$  SD, (n = 5)

Cultivar	Substrate composition	Year				average for year	
		2014		2015		M $\pm$ SD	% to peat
		M $\pm$ SD	% to peat	M $\pm$ SD	% to peat		
'Bad'oryi'	100% peat	0.20 $\pm$ 0.009		0.12 $\pm$ 0.002		0.16 $\pm$ 0.005	
	80% peat + 20% perlite	0.23 $\pm$ 0.007	+15%	0.15 $\pm$ 0.004	+25%	0.19 $\pm$ 0.003	+19%
	60% peat + 40% perlite	0.23 $\pm$ 0.006	+15%	0.16 $\pm$ 0.005	+33%	0.19 $\pm$ 0.005	+19%
	40% peat + 60% perlite	0.23 $\pm$ 0.005	+15%	0.15 $\pm$ 0.007	+25%	0.19 $\pm$ 0.006	+19%
	20% peat + 80% perlite	0.17 $\pm$ 0.010	-15%	0.10 $\pm$ 0.013	-17%	0.13 $\pm$ 0.011	-19%
	Mean for cultivar	0.21	+5%	0.14	+17%	0.17	+6%
'Filosof'	100% peat	0.17 $\pm$ 0.005		0.07 $\pm$ 0.002		0.12 $\pm$ 0.003	
	80% peat + 20% perlite	0.20 $\pm$ 0.007	+18%	0.11 $\pm$ 0.004	+57%	0.16 $\pm$ 0.004	+33%
	60% peat + 40% perlite	0.22 $\pm$ 0.004	+29%	0.13 $\pm$ 0.001	+86%	0.17 $\pm$ 0.002	+42%
	40% peat + 60% perlite	0.22 $\pm$ 0.011	+29%	0.13 $\pm$ 0.011	+86%	0.17 $\pm$ 0.011	+42%
	20% peat + 80% perlite	0.09 $\pm$ 0.012	-47%	0.09 $\pm$ 0.009	+29%	0.09 $\pm$ 0.004	-25%
	Mean for cultivar	0.18		0.11		0.14	
Mean for substrate	100% peat	0.19		0.10		0.14	
	80% peat + 20% perlite	0.22		0.13		0.18	
	60% peat + 40% perlite	0.23		0.15		0.18	
	40% peat + 60% perlite	0.23		0.14		0.18	
	20% peat + 80% perlite	0.13		0.10		0.11	

LSD<sub>0.05</sub> essential oils: year -0.3; cultivar - 0.2; substrate - 0.2.

A determining influence on the accumulation of essential oil in basil of both cultivars had substrate factor (the share of substrate factor influence was 66.5%).

## CONCLUSIONS

A rate of perlite in the mixture with peat influences the fresh and dry mass and the concentration of total phenolic compounds, ascorbic acid, carotenoids, as well as essential oil of basil plants. The best combination of peat and perlite was 60 : 40% and 40 : 60%, but it was modified by genotype and year of study.

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